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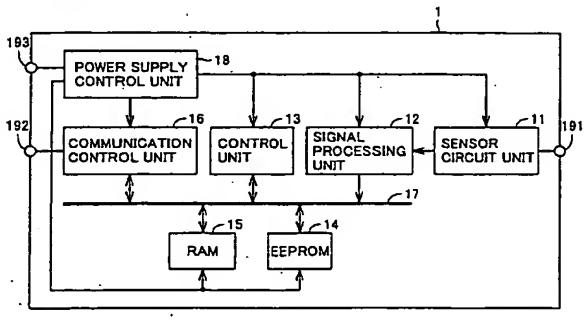
(54) Recording medium and blood glucose monitoring system

(57) A recording medium (1) includes a sensor circuit unit (11) generating a current in accordance with a blood glucose level in blood, and a control unit (13) calculating blood glucose level data from the data obtained by digital conversion of the generated current at signal processing unit (12), writing the calculated data to an EEPROM (14) as a memory unit, reading the blood glucose level data from EEPROM (14) and transmitting the same to a portable terminal on which recording medium (1) is mounted, through a communication control unit (16). The recording medium (1) further includes a power supply control unit (18) receiving power from the portable terminal on which the recording medium (1) is mounted, and supplying power to various portions in the recording medium (1). As a result, the recording medium (1) can be utilized, when mounted on the portable terminal (2), as a blood glucose monitoring apparatus, and can be used in a system for providing bi-directional service between the portable terminal (2) and a server (4) managing the blood glucose information received from the portable terminal (2) connected to a network (5).

FIG.3



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received from the portable terminal connected to a network for providing bi-directional service between the terminal and the server, and the portable terminal to which the recording medium is mounted.

[0014] A still further object of the present invention is to provide a recording medium capable of blood glucose monitoring that is highly portable.

[0015] The present invention provides a recording medium operating mounted on a portable terminal capable of supplying power, including: a communication control unit exchanging data with the portable terminal; a sensor circuit unit generating a current in accordance with a blood glucose level of taken blood; a signal processing unit converting the generated current to a digital data and outputting the data; an electrically erasable and programmable non-volatile memory unit storing blood glucose level data converted based on the data output from the signal processing unit; a control unit converting the data output from the signal processing unit to the blood glucose level data, writing the converted data to the memory unit, reading the blood glucose level data from the memory unit and transmitting the data to the portable terminal through the communication control unit; and a power supply control unit receiving power from the portable terminal and supplying power to the sensor circuit unit, the signal processing unit, the memory unit, the communication control unit and the control unit.

[0016] Preferably, the portable terminal transmits through a communication network, measured blood glucose level data to a server that manages the blood glucose level of a customer.

[0017] Preferably, the portable terminal displays the measured blood glucose level data.

[0018] Preferably, the portable terminal is one of a portable telephone, a personal digital assistant and a portable personal computer.

[0019] According to another aspect, the present invention provides a blood glucose monitoring system including a portable terminal and a recording medium operating mounted on the portable terminal, wherein the portable terminal includes a first communication unit exchanging data with the recording medium, a power supply unit supplying power to the recording medium and a first control unit; the recording medium includes a second communication control unit exchanging data with the portable terminal, a sensor circuit unit generating a current in accordance with blood glucose level of obtained blood, a signal processing unit converting the generated current to digital data and outputting the digital data, an electrically erasable and programmable non-volatile memory unit storing blood glucose level data converted based on the data output from the signal processing unit, a second control unit converting the data output from the signal processing unit to the blood glucose level data and writing in the memory unit, reading the blood glucose level data from the memory unit and transmitting the read data to the portable terminal through the second communication control unit, and a power supply control unit receiving power from the portable terminal and supplying power to the sensor circuit unit, the signal processing unit, the memory unit, the second communication control unit and the second control unit; and the first control unit controls the first communication control unit when the blood glucose data is received from the recording medium.

[0020] Preferably, the portable terminal further includes a third communication control unit exchanging data with the server managing the blood glucose level of the customer through a communication network, and the first control unit further provides to the third communication control unit the blood glucose level data received from the recording medium when transmitting the blood glucose level data to the server.

[0021] Preferably, the portable terminal further includes a display unit displaying the blood glucose level data, and the first control unit further applies to the display unit the blood glucose level data received from the recording medium when displaying the blood glucose data on the display unit.

[0022] According to the recording medium or the blood glucose monitoring system in accordance with the present invention, the blood glucose level can be measured using a portable terminal that can be connected to a network as a blood glucose monitoring apparatus. Therefore, the measured blood glucose level can be transmitted on the network using the portable terminal, and therefore, the blood glucose level data can be managed by a server installed at a medical institution, or the data stored in the server may be utilized for telemedicine.

[0023] Further, according to the recording medium or the blood glucose monitoring system of the present invention, the blood glucose level can be measured using a commercially available portable terminal as the blood glucose monitoring apparatus. Therefore, a dedicated blood glucose monitoring apparatus is unnecessary, a trouble such as failure of measurement resulting from malfunction of the dedicated blood glucose monitoring apparatus can be prevented, and the cost for the user can also be reduced, as the dedicated blood glucose monitoring apparatus is unnecessary.

[0024] According to the recording medium of the present invention, as the measured blood glucose level data is stored as it is on the recording medium, it becomes possible, when the recording medium is mounted to various apparatuses related to diabetes including a medicine (insulin) administering apparatus or a next generation pen device, to share the blood glucose level data among such apparatuses. Thus, very convenient treatment of diabetes such as artificial pancreas that integrates measurement of blood glucose level and administration of appropriate medicine becomes possible.

[0025] Further, according to the recording medium of the present invention, the recording medium itself does not includes the display device and the battery for driving the apparatus, and the display device and power supply battery of the portable terminal on which the recording medium is mounted are utilized. Thus, the recording medium itself can be made very compact, and a blood glucose monitoring apparatus, which is highly portable, is realized.

[0026] The foregoing and other objects, features, aspects and advantages of the present invention will become more apparent from the following detailed description of the present invention when taken in conjunction with the accompanying drawings.

blood sample is applied to test paper 6 by putting a puncture needle on one's finger tip, for example, by a dedicated puncture device having a puncture needle at a tip end, thus obtaining a small amount of blood.

[0038] Referring to Fig. 3, recording medium 1 includes a sensor circuit unit 11, a signal processing unit 12, a control unit 13, an EEPROM (Electrically Erasable Programmable Read Only Memory) 14 as a non-volatile memory unit, an RAM (Random Access Memory) 15 as a volatile memory unit, a communication control unit 16, a bus 17 and a power supply control unit 18. Recording medium 1 further includes an inlet port 191, a data input/output terminal 192 and a power supply terminal 193.

[0039] Inlet port 191 is for inserting test paper 6 for mounting the test paper 6 on which obtained blood is applied, on recording medium 1.

[0040] Data input/output terminal 192 is joined to a data input/output terminal of portable telephone 2, and exchanges data between recording medium 1 and portable telephone 2.

[0041] Power supply terminal 193 is joined to a power supply output terminal of portable telephone 2, and power is supplied from power supply unit of portable telephone 2 to power supply control unit 18.

[0042] Sensor circuit 11 uses, for example, an enzyme electrode having glucose dehydrogenase fixed with a redox mediator interposed, as an electrode, and generates a current from enzyme reaction between glucose in the blood and glucose dehydrogenase. Thus, the recording medium 1 in accordance with the present invention is capable of detecting blood glucose from a very small amount of blood.

[0043] Signal processing unit 12 converts the current generated from sensor circuit unit 11 to a digital signal and outputs the same.

[0044] Control unit 13 is, for example, an MPU (Micro Processing Unit), that performs conversion of the data converted to digital data and output from signal processing unit 12 to blood glucose level data, writing of blood glucose level data to EEPROM14 storing the blood glucose level data and reading of the blood glucose level data from EEPROM14, and transmission of read glucose level data to portable telephone 2 on which recording medium 1 is mounted.

[0045] EEPROM14 is an electrically erasable and programmable non-volatile flash memory, which stores blood glucose levels of a plurality of measurements.

[0046] RAM15 is a work memory for control unit 13.

[0047] Communication control unit 16 exchanges data between recording medium 1 and potable telephone 2 through data input/output terminal 192.

[0048] Bus 17 is a data communication path between each of sensor circuit unit 11, signal processing unit 12, control unit 13, EEPROM 14, RAM 15 and communication control unit 16.

[0049] Power control unit 18 receives power from portable telephone 2 through power supply terminal 193, as recording medium 1 itself does not have any power source, and supplies a prescribed power for operation, to sensor circuit unit 11, signal processing unit 12, control unit 13, EEPROM 14, RAM15 and communication control unit 16.

[0050] When test paper 6 with obtained blood applied is inserted to inlet port 191 of recording medium 1, sensor circuit unit 11 detects the current generated in accordance with the blood glucose level of the blood on test paper 6, and outputs the detected current to signal processing unit 12. Signal processing unit 12 converts the current generated by sensor circuit unit 11 to digital data and outputs to control unit 13. Control unit 13 temporarily writes the data received from signal processing unit 12 to RAM 15, reads the data from RAM 15, converts the read data to blood glucose level data, and writes to EEPROM 14.

[0051] Control unit 13 transmits the blood glucose level data to portable telephone 2 through communication control unit 16, so as to display the result of measurement of blood glucose level on a display unit of portable telephone 2, or to transmit the blood glucose level data from portable telephone 2 to server 4 through network 5. Further, upon reception of a request for transmitting blood glucose level data of the past necessary for displaying the progress of the blood glucose level from portable telephone 2, control unit 13 successively reads the past blood glucose level data from EEPROM 14 in order, writes the read data in RAM 15 temporarily and reads the data from RAM 15 and transmits to portable telephone 2 through communication control unit 16.

[0052] Fig. 4 shows a configuration of the blood glucose monitoring system including recording medium 1 and portable telephone 2. Portable telephone 2 includes communication control units 21, 22, a control unit 23, a display unit 24, a bus 25 and a power supply unit 26. Portable telephone 2 further includes a data input/output terminal 271, a power supply terminal 272 and an antenna 273.

[0053] Data input/output terminal 271 is joined to data input/output terminal 192 of recording medium 1, and exchanges data between recording medium 1 and portable telephone 2.

[0054] Power supply terminal 272 is joined to power supply terminal 193 of recording medium 1, and supplies power from power supply unit 26 of portable telephone 2 to power supply control unit 18 of recording medium 1.

[0055] Antenna 273 transmits blood glucose level data measured by recording medium 1 to wireless base station 3. Through wireless base station 3 and network 5, the blood glucose level data is transmitted to server 4.

[0056] Communication control unit 21 exchanges data between portable telephone 2 and recording medium 1 through data input/output terminal 271.

[0057] Communication control unit 22 exchanges data between portable telephone 2 and wireless base station 3 connected to network 5, through an antenna 273.

[0058] Control unit 23 is implemented by an MPU, for example, which controls communication control units 21, 22 and display unit 24, to perform transmission/reception of data to and from the mounted recording medium 1,

transmit the measured blood glucose level data.

[0071] Server 4 stores the blood glucose level data received from portable telephone 2 in customer database 41, in association with profile data of the customer. The profile data of the customer includes information identifying the customer such as name, age and sex, clinical history of the customer, past diagnosis, contact address in case of emergency, and contact address of the customer's family in case of emergency. Server 4 makes a diagnosis on the blood glucose level data of the customer received from portable telephone 2, and transmits the result of diagnosis and various advise information in accordance with the result of diagnosis, to portable telephone 2. Further, when it is determined that the blood glucose level data of the customer is abnormal, server 4 transmits the abnormal blood glucose level data to contract physician/medical institution 7, and asks for diagnosis on the blood glucose level data.

[0072] Contract physician/medical institution 7 performs analysis and diagnosis of the abnormal blood glucose level data, and transmits the result of diagnosis and related advice information to server 4. Upon reception of the result of diagnosis and advise information on the abnormal blood glucose level data from contract physician/medical institution 7, server 4 transmits the result and information to portable telephone 2. When the contract physician/medical institution 7 determines, as a result of diagnosis on the abnormal blood glucose level data, that an urgent response is necessary, the physician or institution transmits emergency information to server 4, including an instruction for the customer to have a consultation at a hospital 8 nearby, in addition to the result of diagnosis and the advise information.

[0073] Upon reception of the emergency information from contract physician/medical institution 7, server 4 transmits an emergency report based on the emergency information to portable telephone 2, as well as to the contact address of the customer's family stored in the customer database. Further, server 4 transmits information including consultation reservation of the customer, profile data of the customer, the abnormal blood glucose level data measured this time, and a result of diagnosis made by the contract physician/medical institution 7, to hospital 8 nearby, designated by contract physician/medical institution 7.

[0074] Upon reception of the information of a customer requiring urgent consultation from server 4, the hospital 8 reserves consultation, in accordance with the instruction from contract physician/medical institution 7 and makes a contact to the customer, or when it is impossible for the customer to visit the hospital 8 by himself/herself, delivers an ambulance to the customer. Thus, the customer has a consultation at the hospital 8.

[0075] A process flow of the above described telemedicine system 200 will be described in detail with reference to Figs. 6 to 8.

[0076] Referring to Fig. 6, the customer receiving the service of telemedicine system 200 transmits, in advance, profile data of the customer from portable telephone 2 to server 4 (step S1), and server 4 registers the profile data of the customer received from portable telephone 2 in a customer data server 41 (step S2). The customer puts the obtained blood sample on test paper 6, inserts the test paper 6 to recording medium 1, and mounts the recording medium 1 on portable telephone 2 to measure the blood glucose level (step S3). When measurement of the blood glucose level ends, the customer accesses from portable telephone 2 to server 4, and transmits the measured blood glucose level data to server 4 (step S4).

[0077] Server 4 receives the blood glucose level data from portable telephone 2 (step S5), analyzes the blood glucose level data, and makes a diagnosis of "normal", "slightly problematic", "problematic" and "abnormal" (step S6).

[0078] When it is diagnosed that the received blood glucose level data is "normal" (step S7), the server 4 transmits the result of diagnosis and various advise information based on the analysis/diagnosis to portable telephone 2 (step S8). The customer, who have sent the blood glucose level data from portable telephone 2, receives the result of diagnosis and advise information on the transmitted blood glucose level data, from server 4 (step S9).

[0079] When it is diagnosed that the blood glucose level data is not "normal" (step S7), the server 4 further requests additional measurement of the blood glucose level, and an answer to a questionnaire transmitted as attached, to portable telephone 2 (step S10).

[0080] When the customer receives at portable telephone 2 the request of additional measurement and attached questionnaire from server 4 (step S11), the customer again obtains a blood sample, applies it to test paper 6, inserts the test paper 6 to recording medium 1, mounts recording medium 1 on portable telephone 2, and measures the blood glucose level (step S12). Then, the customer accesses from portable telephone 2 to server 4, and transmits the re-measured blood glucose level data and the answer to the questionnaire received from server 4, to server 4 (step S13).

[0081] Upon reception of the re-measured blood glucose level data and the answer to the questionnaire from portable telephone 2 (step S14), server 4 again analyzes the received blood glucose level data, and again makes a diagnosis of "normal", "slightly problematic", "problematic" and "abnormal" (step S15).

[0082] Referring to Fig. 7, when the re-measured blood glucose level data is diagnosed as not "abnormal" (step S16), the server 4 transmits the result of diagnosis and various advise information based on the analysis/diagnosis to portable telephone 2 (step S17). The customer who again transmitted the blood glucose level data from portable telephone 2 receives the result of diagnosis and the advice information on the re-transmitted blood glucose level data from server 4 (step S18).

[0083] When the read glucose level data is diagnosed again as "abnormal" (step S16), the server 4 determines that consultation with a physician is necessary, and transmits the blood glucose level data that is diagnosed to be abnormal to a contract physician/medical institution 7 that has a contract to make diagnoses on the abnormal blood glucose level data (step S19). When the contract physician/medical institution 7 receives the measurement data

[0095] The portable telephone 2 described in the embodiments above may be a PDA (Personal Digital Assistance), a portable personal computer, a digital camera, a portable television or other communication terminal, provided that it can accommodate the recording medium 1 and connectable to a network.

[0096] According to the embodiments of the present invention, as the recording medium 1 is mounted on a network connectable portable telephone 2 to be used as a blood glucose monitoring apparatus, it becomes possible for a diabetes patient who needs monitoring of blood glucose level to transmit the measured blood glucose level data directory from portable telephone 2 through network 5 to a server 4 that is installed at a medical institution or the like, and to receive various medical services from server 4, through network 5.

[0097] Further, according to the embodiments of the present invention, as the blood glucose level can be monitored using recording medium 1 mounted on a commercially available portable telephone 2 as a blood glucose monitoring apparatus, it becomes unnecessary to have a dedicated blood glucose monitoring apparatus. Therefore, a trouble such as failure in monitoring resulting from malfunction of the dedicated blood glucose monitoring apparatus can be prevented, and the cost can also be reduced, as the dedicated blood glucose monitoring apparatus is unnecessary.

[0098] Further, according to the embodiments of the present invention, as measured blood glucose level data is directly recorded on recording medium 1, when recording medium 1 is mounted on various devices related to diabetes such as medicine (insulin) administering device or a next generation pen device, the blood glucose level data can be shared among the devices, and very convenient treatment of diabetes such as artificial pancreas that has the functions of measuring blood glucose level and administration of medicine integrated becomes possible.

[0099] Further, according to the embodiments of the present invention, the display unit of portable telephone 2 on which recording medium 1 is mounted is used as the display unit for displaying the measured blood glucose level, and the power supply battery of portable telephone 2 on which recording medium 1 is mounted is used as an operational power supply of recording medium 1, and therefore, the recording medium 1 itself does not require any display unit or a power supply battery. Therefore, recording medium 1 itself can be made very compact, and a blood glucose monitoring apparatus which is highly portable is realized.

[0100] Although the present invention has been described and illustrated in detail, it is clearly understood that the same is by way of illustration and example only and is not to be taken by way of limitation, the spirit and scope of the present invention being limited only by the terms of the appended claims.

Claims

1. A recording medium (1) operating mounted on a portable terminal (2) capable of supplying power, comprising:

   a communication control unit (16) exchanging data with said portable terminal (2);

   a sensor circuit unit (11) generating a current in accordance with a blood glucose level of taken blood;

   a signal processing unit (12) converting said generated current to a digital data and outputting the data;

   an electrically erasable and programmable non-volatile memory unit (14) storing blood glucose level data converted based on the data output from said signal processing unit (12);

   a control unit (13) converting the data output from said signal processing unit (12) to said blood glucose level data, writing the converted data to said memory unit (14), reading said blood glucose level data from said memory unit (14) and transmitting the data to said portable terminal (2) through said communication control unit (16); and

   a power supply control unit (18) receiving power from said portable terminal (2) and supplying power to said sensor circuit unit (11), said signal processing unit (12), said memory unit (14), said communication control unit (16) and said control unit (13).

2. The recording medium (1) according to claim 1, wherein
   said portable terminal (2) transmits said measured blood glucose level data to a server (4) managing blood glucose level of a customer, through a communication network (5).

3. The recording medium (1) according to claim 1 or 2, wherein
   said portable terminal (2) displays said measured blood glucose level data.

4. The recording medium (1) according to any of claims 1 to 3, wherein
   said portable terminal (2) is one of a portable telephone, a personal digital assistant and a portable personal computer.

5. A blood glucose monitoring system including
   a portable terminal (2), and
   a recording medium (1) operating mounted on said portable terminal (2), wherein

FIG.1

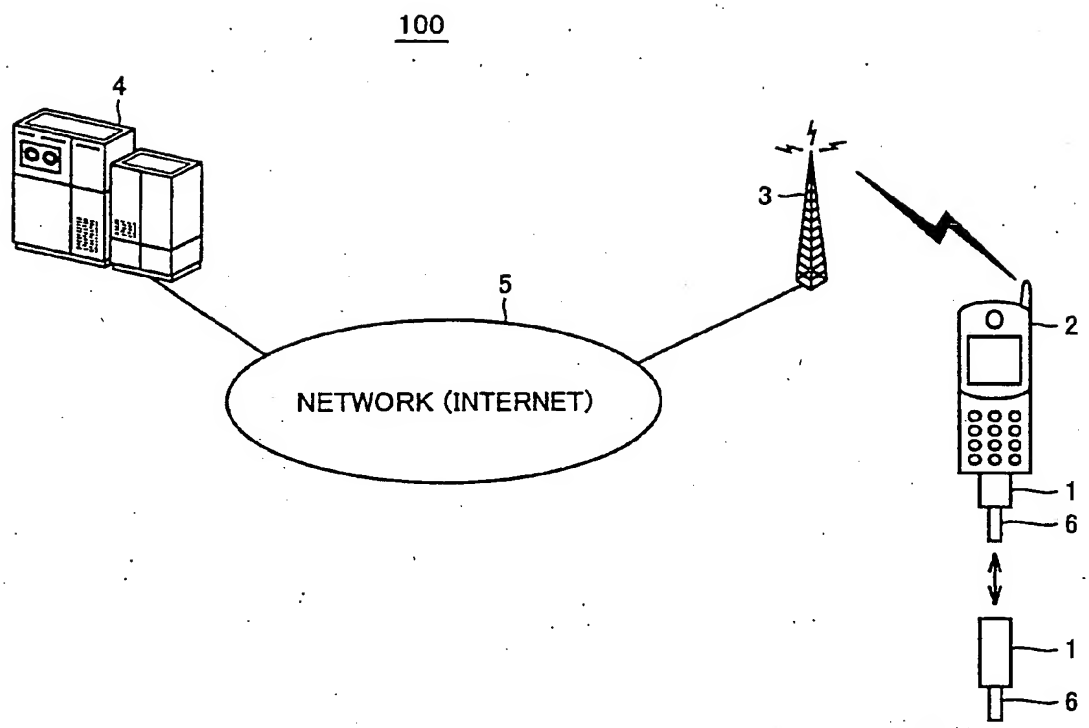


FIG.4

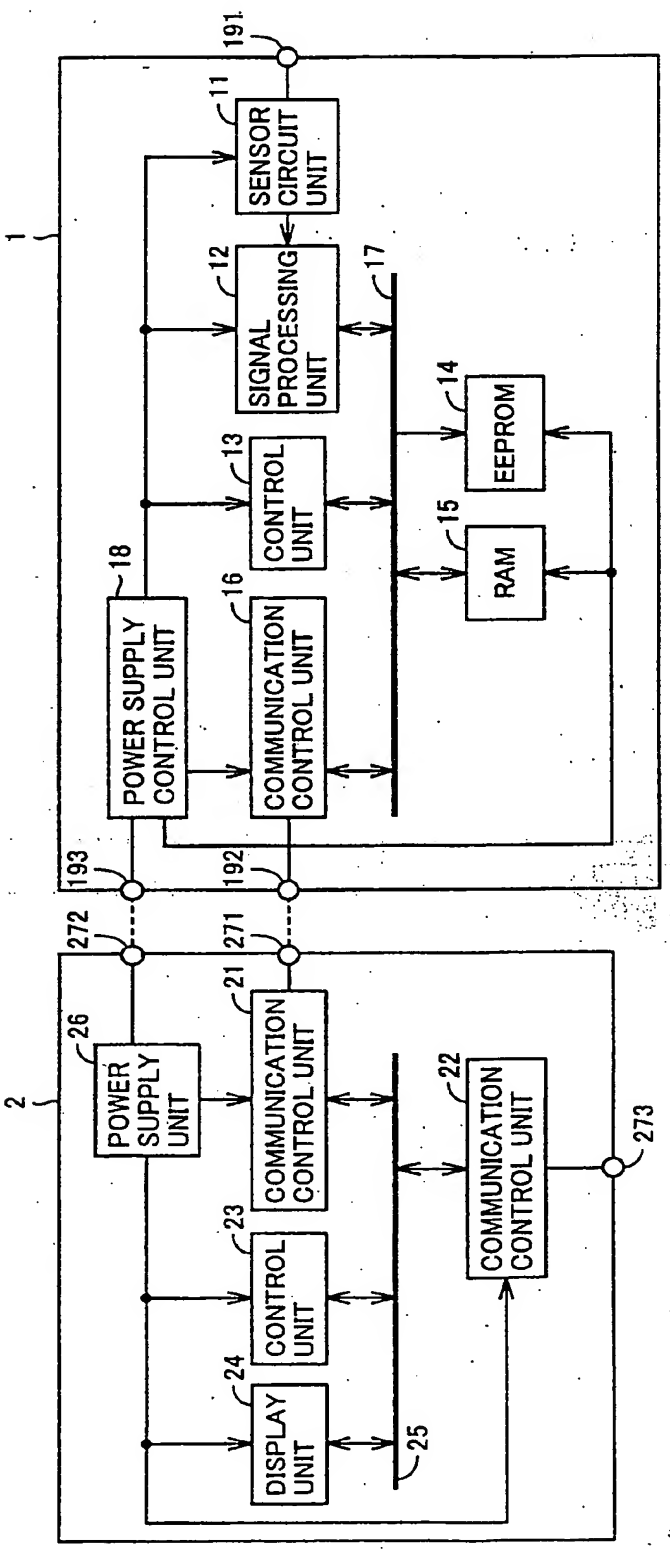
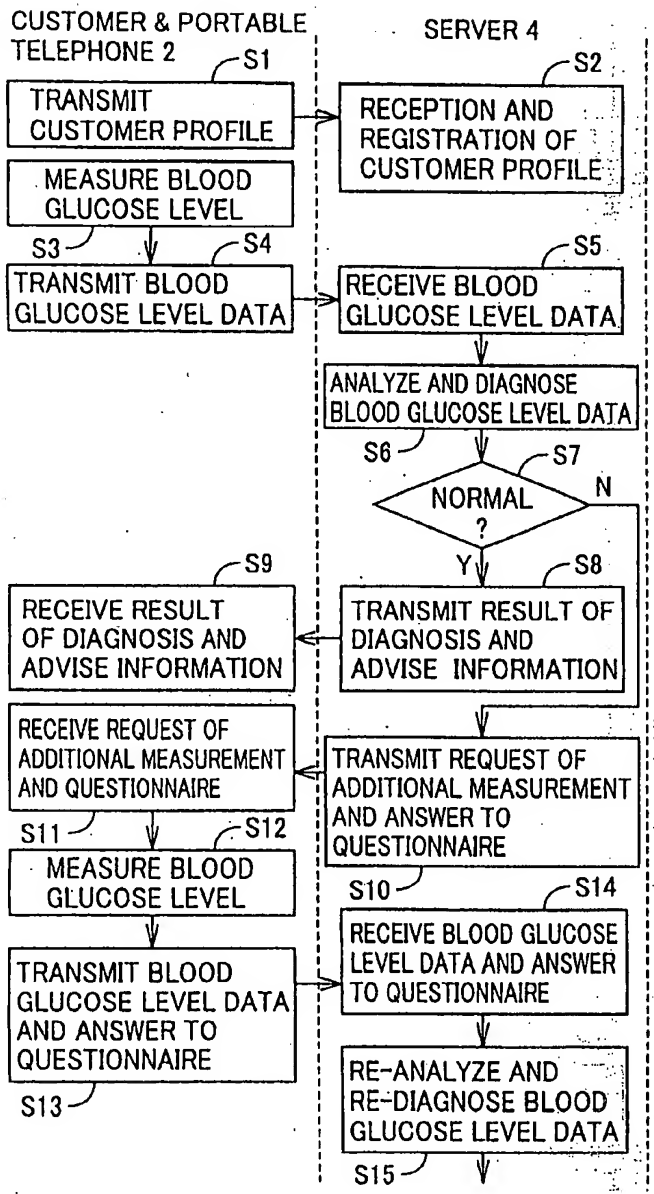

1
2
191
192
193
271
272
273
11
SENSOR CIRCUIT UNIT
12
SIGNAL PROCESSING UNIT
13
CONTROL UNIT
14
EEPROM
15
RAM
16
COMMUNICATION CONTROL UNIT
17
18
POWER SUPPLY CONTROL UNIT
21
COMMUNICATION CONTROL UNIT
22
COMMUNICATION CONTROL UNIT
23
CONTROL UNIT
24
DISPLAY UNIT
25
26
POWER SUPPLY UNIT

FIG.6



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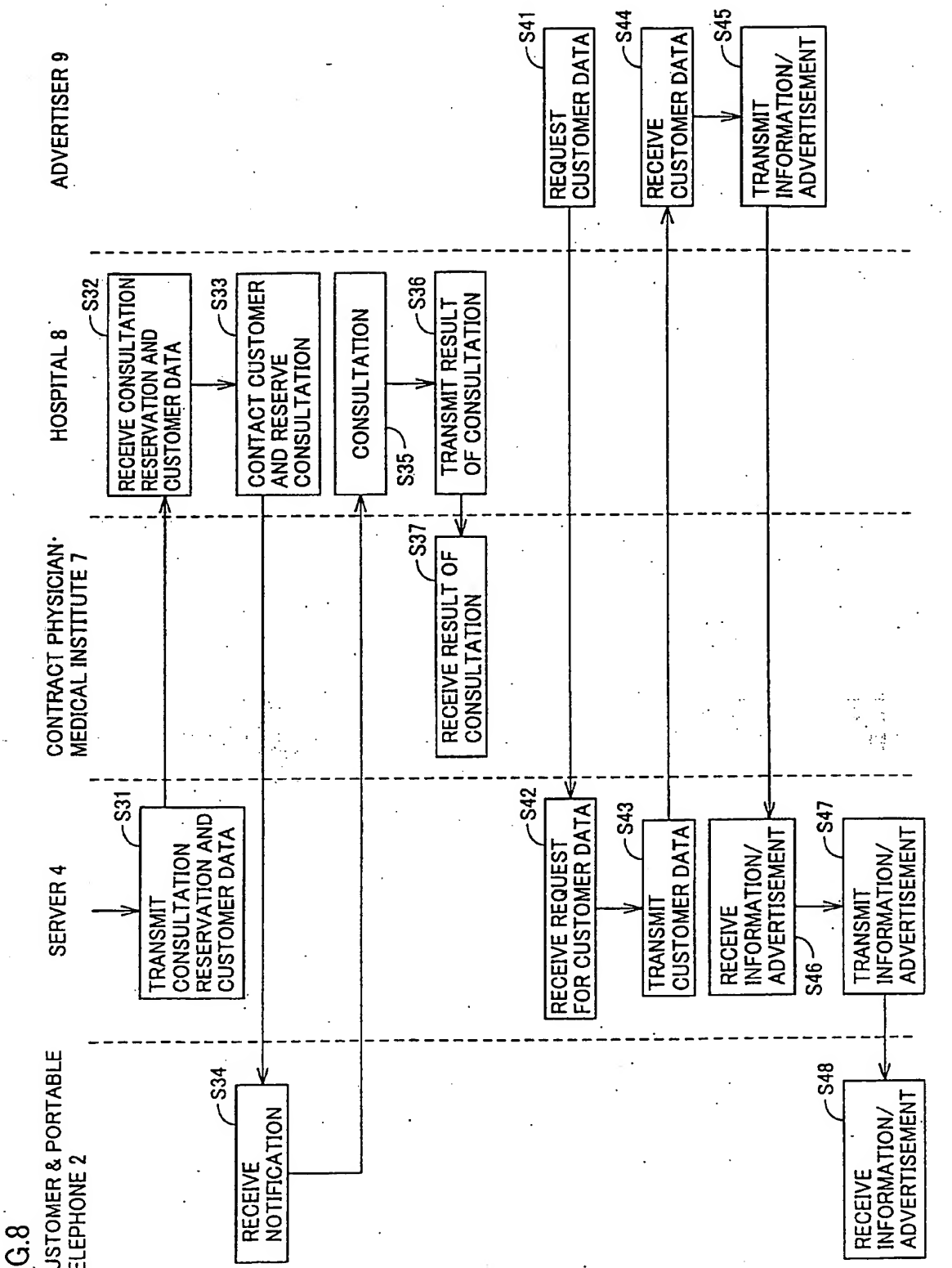
CUSTOMER & PORTABLE TELEPHONE 2
SERVER 4
CONTRACT PHYSICIAN· MEDICAL INSTITUTE 7
HOSPITAL 8
ADVERTISER 9
S31
TRANSMIT CONSULTATION RESERVATION AND CUSTOMER DATA
S32
RECEIVE CONSULTATION RESERVATION AND CUSTOMER DATA
S33
CONTACT CUSTOMER AND RESERVE CONSULTATION
S34
RECEIVE NOTIFICATION
CONSULTATION
S35
S36
TRANSMIT RESULT OF CONSULTATION
S37
RECEIVE RESULT OF CONSULTATION
S41
REQUEST CUSTOMER DATA
S42
RECEIVE REQUEST FOR CUSTOMER DATA
S43
TRANSMIT CUSTOMER DATA
S44
RECEIVE CUSTOMER DATA
S45
TRANSMIT INFORMATION/ ADVERTISEMENT
S46
RECEIVE INFORMATION/ ADVERTISEMENT
S47
TRANSMIT INFORMATION/ ADVERTISEMENT
S48
RECEIVE INFORMATION/ ADVERTISEMENT

FIG.8

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 02 01 7693

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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